S011
A5A31
16

FOREST RESEARCH NOTES

CALIFORNIA FOREST AND RANGE EXPERIMENT STATION

FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE
IN COOPERATION WITH THE UNIVERSITY OF CALIFORNIA
BERKELEY

Research Note No. 16 June 4, 1937

REDWOOD TRACTOR YARDING COSTS

AS AFFECTED BY SLOPE GRADIENT AND LOAD VOLUME

William Hallin, Assistant Silviculturist

Realization of the importance of planning in logging is essential to maximum efficiency. In tractor yarding day to day and log to log planning is of far greater importance than in steam yarding because each log may be taken out in many possible load combinations, often over any one of several possible routes, and in almost any order; whereas in steam yarding once the landing is rigged up the order is quite definitely established. This importance of short time planning on the ground as the logs are removed makes very close supervision essential in tractor logging. The hook tender (or side boss) must spend much of his time right where the loads are made up.

Basic data on most efficient slope gradients and most efficient load size, which are essential to proper planning, have been determined by time studies completed in the redwood region.1/

1/ See Research Note No. 15. Comparative costs for slackline, highlead and tractor yarding. H. L. Person.

LIBRARY

JUN 24 1968

ROCKY MOUNTAIN STATION

Slope Gradient

For 75 to 95 horsepower tractors the average optimum out-and-in time per 100 feet horizontal distance occurs for 2000 foot loads (gross scale Spaulding) at 5 percent slopes, for 5000 foot loads at 7 percent slopes, and for 8000 foot loads at 15 percent slopes (see figure 1). These figures apply chiefly to a timber body where it is possible to locate the bunching point so as to give optimum slope with approximately the same tractor haul distance. All results of a study of this kind are essentially averages; consequently some of the heavier logs take more time than shown. With very large logs difficulties may be encountered on slopes of less than 5 percent which will increase the time much beyond the average shown in figure 1. Adverse grades and even favorable grades under 5 percent should, therefore, be avoided if at all possible. This applies equally as well to the short stretch coming into and crossing the landing. On most settings the usual practice is to have this stretch quite flat, and on the settings studied considerable lost time occurred in bringing the larger loads across the landing. A minimum slope of 10 percent would give a better margin for keeping heavy loads moving. It might not, however, give the most efficient results when other conditions controlled the set-up.

The most efficient slope for gaining a given difference in elevation is 30 to 31 percent, depending on the load volume, but for practical purposes it lies between 25 and 35 percent. (see figure 2). Although there are not sufficient data to give a reliable curve for slopes over 35 percent, general observations during the time studies and by various operators indicate that the maximum adverse slope over which 75 to 95 horsepower tractors and arches can go empty lies between 40 and 45 percent. What little data we have on slopes over 40 percent indicates that the in-time on slopes over 40 percent increases very rapidly. Consequently the maximum slope should be very little over 40 percent. Commonly topography and location of timber determine more or less definite points between which the sections of the road or roads must be built. The difference in elevation between two points is constant, but the horizontal road distance decreases as slope increases; consequently the most efficient slope is the 25 to 35 percent which is best for gaining the elevation. If the ground is not steep enough to allow 25 to 35 percent grades the most efficient grade would be the steepest possible grade between the two points, which in turn means that if the slope is constant and less than 35 percent a straight line will give the most efficient grade. If the slope between two points is less than 30 percent but quite variable, a longer route with a more constant slope may be better than a straight line; but this can only be decided on the ground in each individual case when the ground conditions for the alternative routes are known. As the most efficient slope gradient for gaining a given difference in elevation is the same for both in and out trips, the same principles would apply, even if separate roads are used for in and out travel.

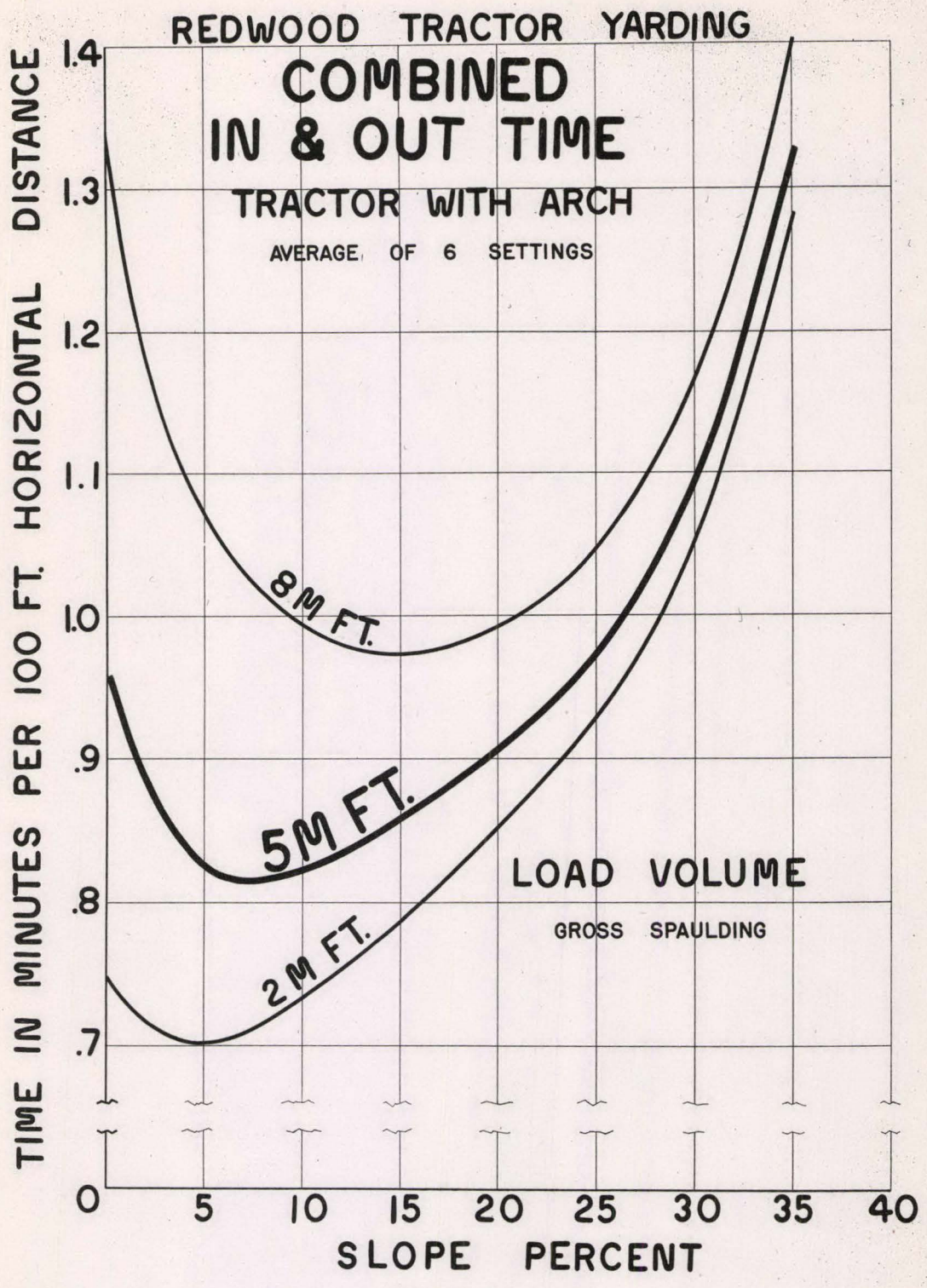
REDWOOD TRACTOR YARDING
COMBINED
IN & OUT TIME
TRACTOR WITH ARCH
AVERAGE OF 6 SETTINGS
TIME IN MINUTES PER 100 FT. HORIZONTAL DISTANCE
1.4
1.3
1.2
1.1
1.0
.9
.8
.7
0
8M FT.
5M FT.
2M FT.
LOAD VOLUME
GROSS SPAULDING
5
10
15
20
25
30
35
40
SLOPE PERCENT

Figure 1

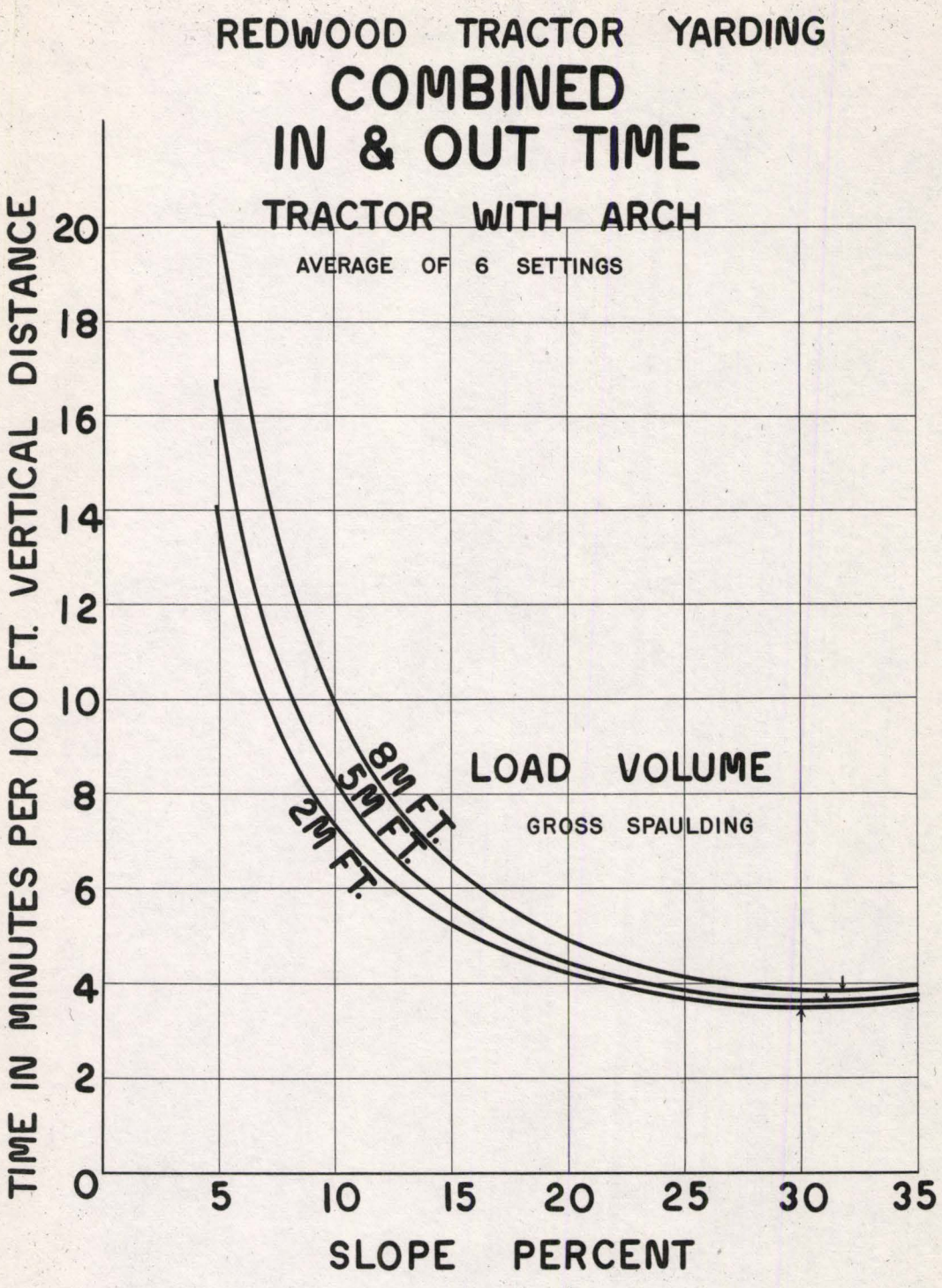
REDWOOD TRACTOR YARDING
COMBINED
IN & OUT TIME
TRACTOR WITH ARCH
AVERAGE OF 6 SETTINGS
TIME IN MINUTES PER 100 FT. VERTICAL DISTANCE
0
2
4
6
8
10
12
14
16
18
20
5
10
15
20
25
30
35
SLOPE PERCENT
8M FT.
5M FT.
2M FT.
LOAD VOLUME
GROSS SPAULDING

Figure 2

Although slope gradient is very important in tractor road location other things must be considered also, such as cost of construction, location and amount of timber, and the need for avoiding sharp curves which cause the logs to bind on the bank or stumps.

Size of Load

Because the total round trip time for large loads is not much greater than it is for small loads, the round trip time per M.B.M. is much smaller for large loads.2/ The round trip time per M.B.M. for 1,000 foot loads (gross scale) is approximately four times that for 5,000 foot loads (see figure 3). Loads from 5,000 to 8,000 feet (gross scale) are the most efficient. The data for loads over 8,000 feet are not adequate as the basis for definite conclusions, but this weakness is not serious because the capacity of the arch does not permit many loads over 8,000 feet.

The following data taken from figure 3 illustrate the value of large loads. Assuming all loads to be 4,000 feet or 6,000 feet the output would increase 27 percent in changing from 4,000 feet to 6,000 feet, or in a more extreme case the output would increase 91 percent in changing from 3,000 foot loads to 7,000 foot loads. Size of load can be increased by taking in more logs per load or by bucking longer logs. Both methods should be used.

The ideal condition would be single-log loads of 5000 feet and over. Some of the advantages of single-log loads are: less time for setting chokers, hooking and unhooking, assembling or bunching loads, and lifting load and adjusting it in the arch. Obviously, all logs cannot be 5000 feet or more in volume; but by cutting more long logs the average volume per log can be markedly increased. On the selectively cut Henry Creek area 56 percent of a total of 791 logs scaled were 52 inches or more in diameter and 90 percent were 37 inches or more. A 52-inch log 40 feet long scales 5061 feet (gross Spaulding) and a 37-inch log 40 feet long scales 2531 feet. In this case by cutting large logs not over 40 feet in length approximately half of them could be taken in single log loads 5000 feet or over in volume and nearly all in either one or two-log loads 5000 feet or over in volume.3/

In smaller timber, such as is commonly found in Mendocino County, much of the timber could be logged in tree lengths and bucked at the landing. In addition to having greater volume per log, by use of tree lengths and coordination of falling with road location, the amount of spur roads or travel off the roads could be reduced.

2/ For further discussion see Importance of large loads in redwood tractor logging. R. Stahelin and W. Hallin. West Coast Lumberman. February 1937.

3/ On this operation the lack of a bucking saw at the mill prevented the use of long logs.

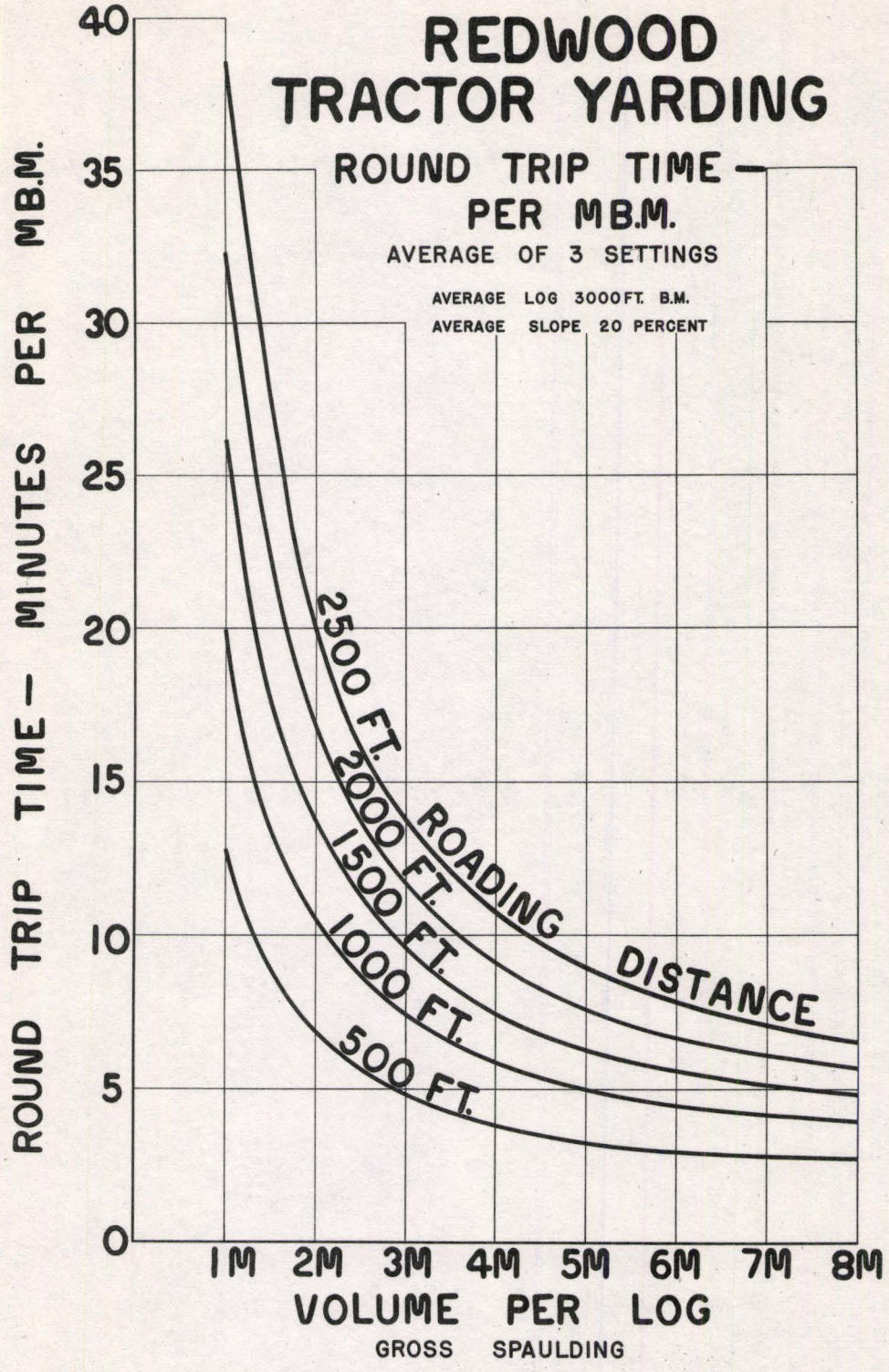
REDWOOD
TRACTOR YARDING
ROUND TRIP TIME — PER M B.M.
AVERAGE OF 3 SETTINGS
AVERAGE LOG 3000 FT. B.M.
AVERAGE SLOPE 20 PERCENT
ROUND TRIP TIME — MINUTES PER M B.M.
40
35
30
25
20
15
10
5
0
2500 FT.
2000 FT.
1500 FT.
1000 FT.
500 FT.
ROADING DISTANCE
1M 2M 3M 4M 5M 6M 7M 8M
VOLUME PER LOG
GROSS SPAULDING

Figure 3

Uniform Production

For most efficient results a uniform flow of logs into the landing is desirable. Roading delays due to waiting for logs to be bunched by a skid cat or double drum, or waiting for peelers to finish peeling the logs, should be eliminated. Delays due to waiting for logs to be bunched can be largely eliminated by using long logs and by bunching logs, when necessary, in small groups some time ahead of the roading. Any extra peeling necessary in addition to that done by the regular peelers should be done at the landing. On all settings studied where this extra peeling was done in the woods considerable lost time resulted from waiting for peelers. In some cases this increased the total time as much as 12 percent. In order to insure uniformity of production of logs, close supervision is necessary to see that long hauls are balanced with short hauls rather than to clean out an area in one sweep from the landing to the back end of the setting.

In conclusion, data presented show some of the effects upon tractor yarding efficiency of slope gradients and size of loads. Much, however, remains to be known. Realization of maximum efficiency in the redwoods will come only with further experience in tractor operation, adequate cost records, mechanical studies, and additional time studies.